8. Employing Concept Definition Techniques to Deliver Value on the RAN Air Warfare Destroyer Program

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Abstract

Modern, complex development systems pose risks in defining the right system solution, building/integrating/delivering the capability and sustaining the capability through the complete lifecycle of that system. Major defence acquisition programs, like the SEA 4000 Royal Australian Navy (RAN) Air Warfare Destroyer (AWD) Program are no different. This presentation describes concept engineering processes employed on the AWD combat system during the capability definition stage of the Program.

Concept definition is a critical activity of any major system development, requiring a balanced approach to multiple stakeholder considerations. The AWD Program has met this challenge by employing a collaborative team approach, early systems architecting and judicious use of Model Based Systems Engineering (MBSE). In this presentation, it is shown how Operational Activity models and supporting architectural views have been successfully used to communicate the system capability with the AWD capability sponsors. As the program has progressed, this MBSE environment has been progressively expanded to include additional SysML system composition and system behaviour model elements to support the system definition activities. A significant "by-product" of the system model has been the ability to identify, quantify and perform technical risk assessment on all system interfaces in order to provide a lead indicator of the cumulative integration risk to the program. Using this information, the architecture has been incrementally refined during concept definition in order to ensure the program integration risk has been minimized whilst ensuring other key stakeholder values have been satisfied.

Key lessons from this presentation demonstrate the applicability of MBSE techniques in complex/large programs and the reality that theoretical application of MBSE must be tailored and augmented with other visualisations and tools to communicate with the variety of stakeholders engaged in the concept definition phase of the program.

Presenter Biography

Steve Saunders, FIEAust CPEng, is an Engineering Fellow for Raytheon Australia. He received his Bachelor of Electrical Engineering from the University of Technology Sydney (UTS) with first class Honors in 1990. He has worked with Rockwell International, Boeing Australia and now Raytheon Australia on Australian Defence projects in various Systems Engineering Management, Requirements Development, Architecture, Design and Test roles. He is a Raytheon certified architect having completed the Raytheon Certified Architect Program in 2005.

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14. ABSTRACT **Modern, complex development systems pose risks in defining the right system solution, building/integrating/delivering the capability and sustaining the capability through the complete lifecycle of that system. Major defence acquisition programs, like the SEA 4000 Royal Australian Navy (RAN) Air Warfare Destroyer (AWD) Program are no different. This presentation describes concept engineering processes employed on the AWD combat system during the capability definition stage of the Program.**

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Steve has been involved in the Royal Australian Navy's Air Warfare Destroyer Program since 2005 as the Combat System Chief Architect working in phase 2 of the Program to establish the Combat System architecture. He is now the AWD Combat System Chief Engineer and Combat System design authority.

Steve has written numerous articles on Systems Engineering and System architecting and has an interest in improving System Engineering and System Architecting maturity and the agility of Systems Engineering to support the rapidly evolving technology environment and complexity within the defence industry.

Presentation

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Agenda

➢ What is the Problem with Systems Engineering Today?

➢ How is Concept Engineering Used on the AWD Program
  ▪ Background
  ▪ MBSE Approach
  ▪ Useful 'by-products'

➢ Lessons from the AWD Program

➢ Key Take-Aways

➢ Questions

The Term Concept Engineering is used to define the activities carried out in the
"Concept Definition" phase of a Program

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What is the Problem with Systems Engineering (SE) Today?

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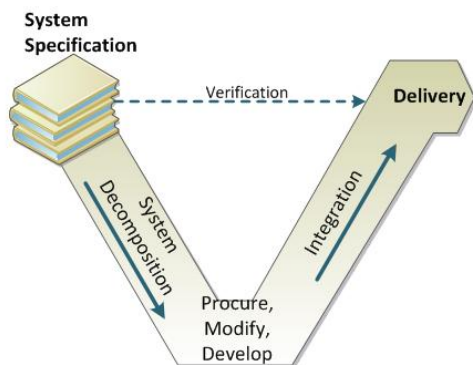DSTO Edinburgh, SA   UNCLASSIFIED   Page 3

What is the Problem with SE Today?

> The **'Easy'** Phases – Systems Requirement to Delivery

- Systems Engineering Processes are mature and well understood

- Transforms Requirements to verified System

- MBSE or Document Centric or Hybrid approaches applicable

- Reasonable tool support

But...

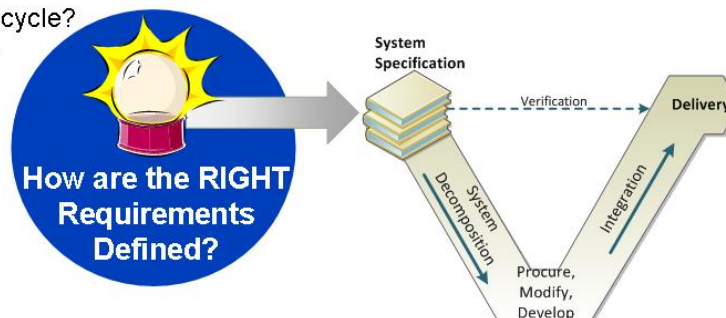DSTO MBSE Symposium, 27-28 Nov 2012, DSTO Edinburgh, SA   UNCLASSIFIED   Page 4

What is the Problem with SE Today?

> Assertion → There is a Problem!

- How are the **right** requirements defined?
  - Will the realisation of the requirements be affordable?
  - Can the requirements be verified?
  - Realisable in available technology?
  - Considers full lifecycle?
  - Meets the need?

How are the RIGHT Requirements Defined?

Concept Definition (Concept Engineering)
Helps Ensure the Right Requirements are Specified

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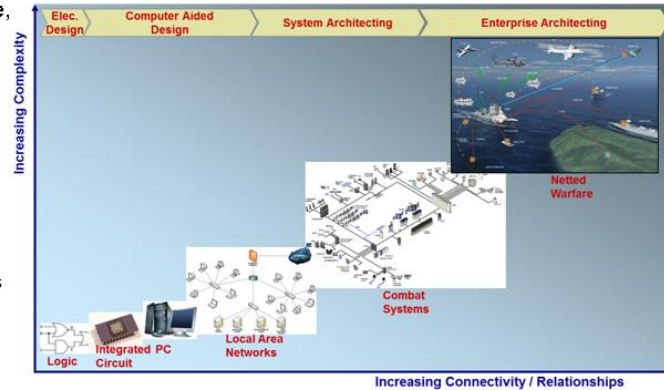
What is the Problem with SE Today?

➢ Why may Concept Definition Phase be Skipped or Superficially Addressed? -- It is HARD!

- **SOFT** Engineering
  - · Business Language,
  - · Fuzzy Criteria,
  - · Best fit rather than exact answers
- It is **COMPLEX…**
  - · Components
  - · Systems
  - · Enterprises
  - · People / Processes
  - · Sociological
  - · Political
  - · Environmental

Concept Definition is HARD(er) than System Definition
Often Overlooked – Has potential For High Impact on Program

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HOW IS CONCEPT ENGINEERING USED ON SEA4000 AWD PROGRAM

How is Concept Engineering used on AWD -
Background

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➤ The Royal Australian Navy's (RAN) Air Warfare Destroyer (AWD) Program is employing a mix of strategies and contracting mechanisms to deliver a new major surface combatant to the RAN within an aggressive timeframe

➤ 8 Years to...
  ▪ Select Equipment and Complete the Design
  ▪ Build Shore Facilities & Integration Facilities
  ▪ Build the Shipyard
  ▪ Build the Lead Ship
  ▪ Integrate and deliver the Capability

➤ The AWD Program
  ▪ has met major Program milestones,
  ▪ has passed System CDR,
  ▪ keel Layed – Future Destroyer HOBART
  ▪ ship blocks for all 3 ships are in production,
  ▪ has excellent customer relationships,
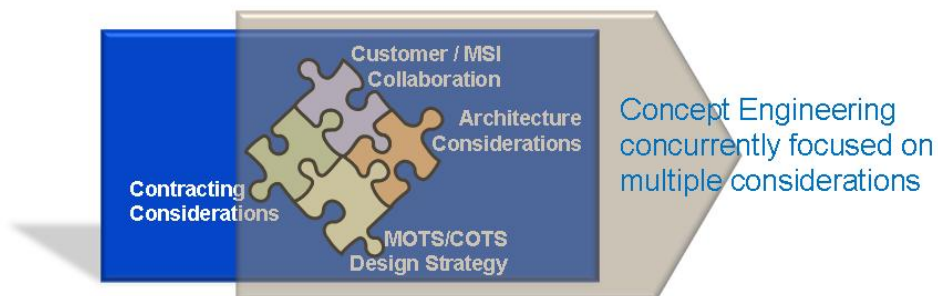 ▪ is scheduled to deliver the required capability to the RAN in 2016

Courtesy AWD Alliance

How is Concept Engineering used on AWD –
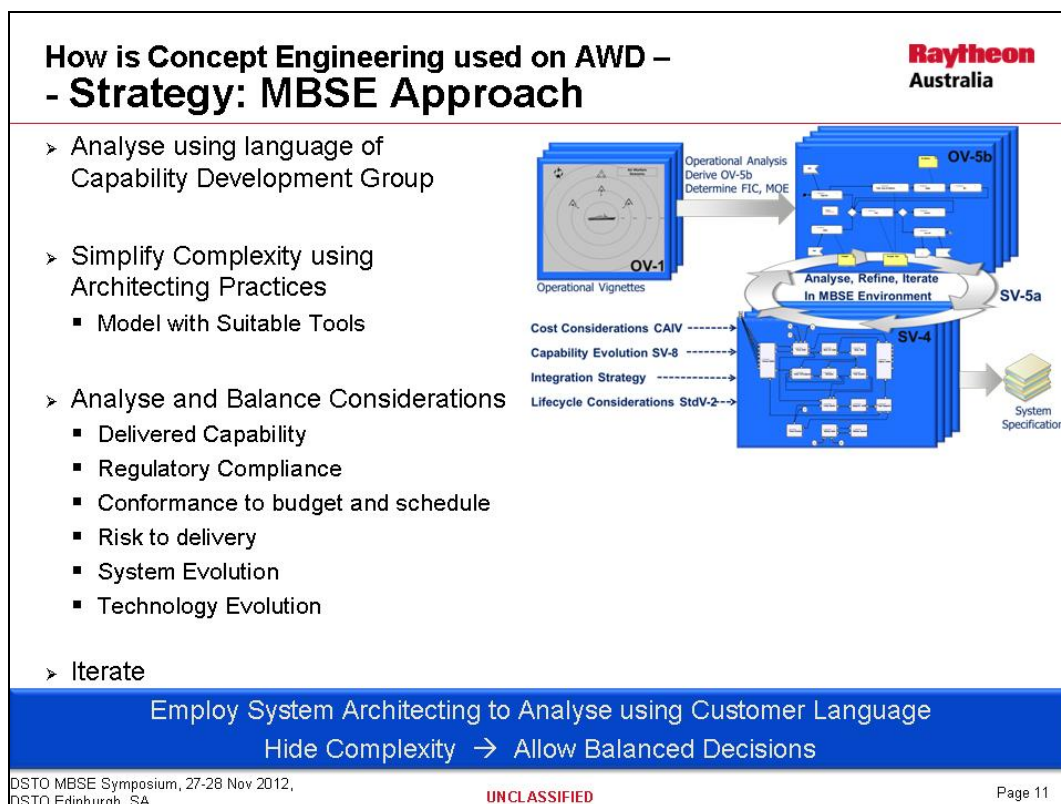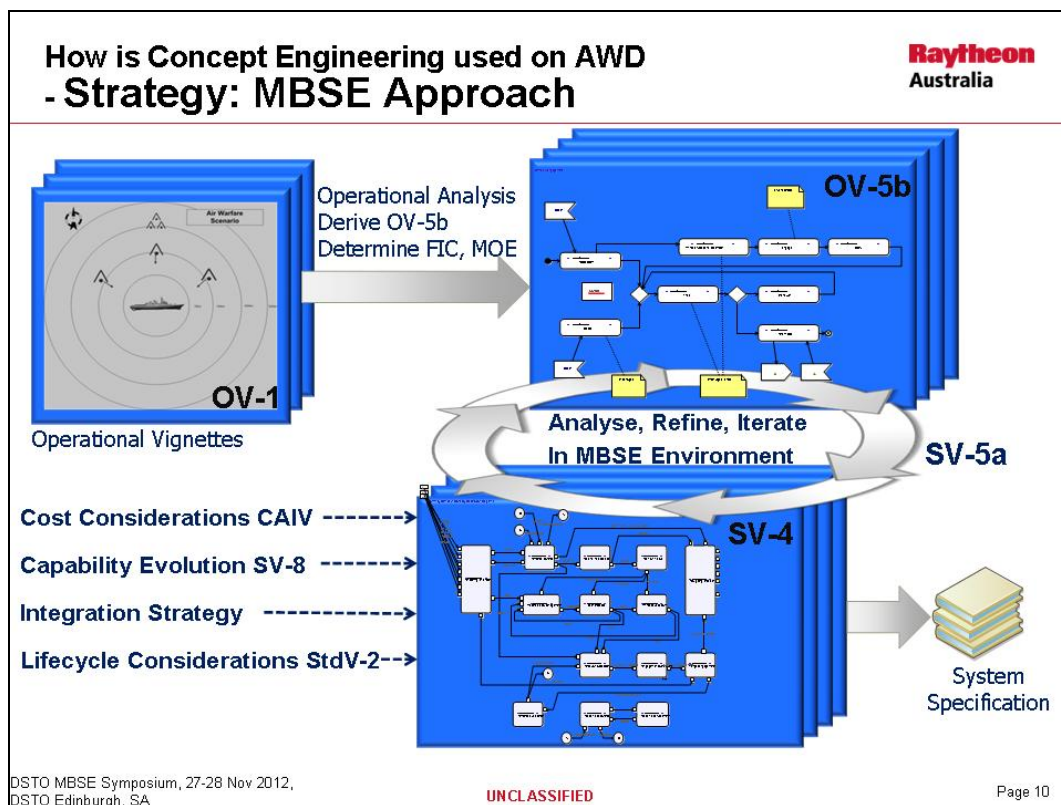# A new Way of Doing Business

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➤ RAN Requires a new Capability "No Later Than" with Set Funding
➤ Schedule/Cost Constraints Require...
  ▪ Collaboration between the Customer and the Mission System Integrator (MSI)
  ▪ Stakeholders to Work Cooperatively for Improved Program Performance and Agility
  ▪ Rapid Development of the Capability (MOTS/COTS vs New Development)

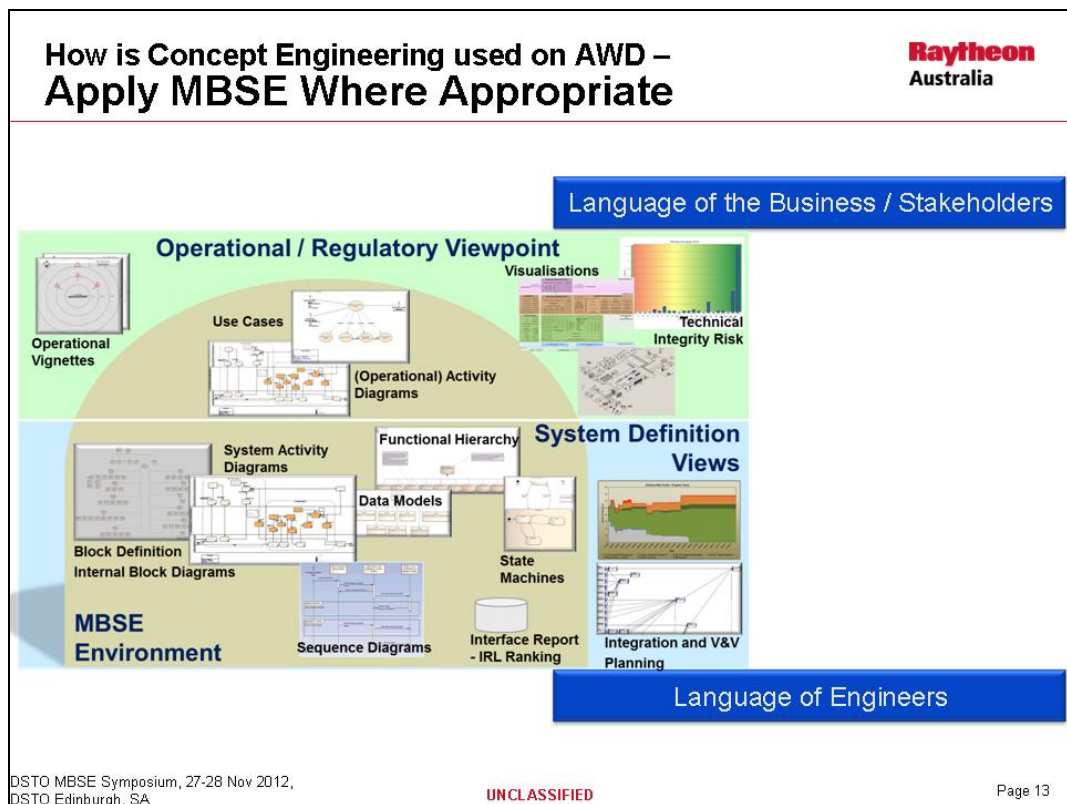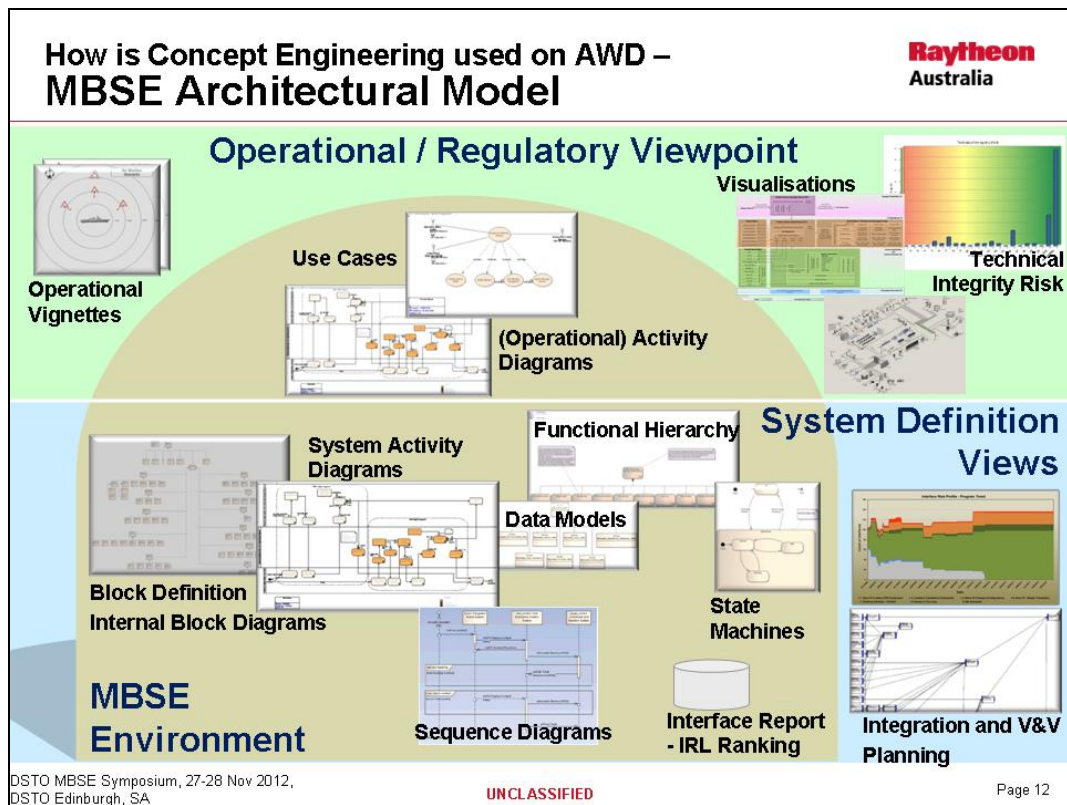➤ Ensuring the System is Supportable for the Life of Type

Customer / MSI Collaboration

Architecture Considerations

Contracting Considerations

MOTS/COTS Design Strategy

Concept Engineering concurrently focused on multiple considerations

How is Concept Engineering used on AWD
- Strategy: MBSE Approach

How is Concept Engineering used on AWD –
- Strategy: MBSE Approach

➤ Analyse using language of Capability Development Group

➤ Simplify Complexity using Architecting Practices
  ▪ Model with Suitable Tools

➤ Analyse and Balance Considerations
  ▪ Delivered Capability
  ▪ Regulatory Compliance
  ▪ Conformance to budget and schedule
  ▪ Risk to delivery
  ▪ System Evolution
  ▪ Technology Evolution

➤ Iterate

Employ System Architecting to Analyse using Customer Language
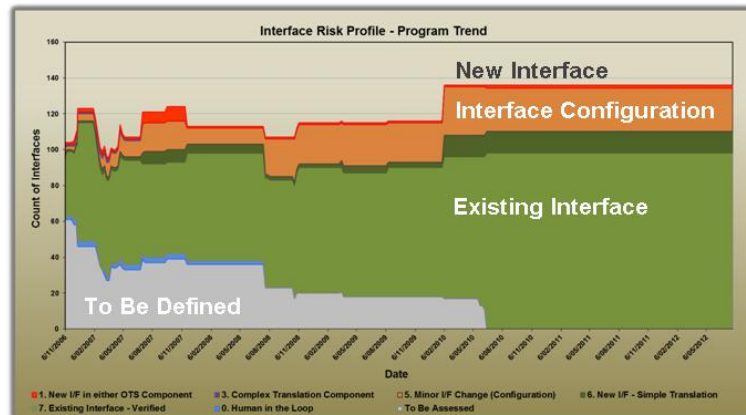Hide Complexity → Allow Balanced Decisions

How is Concept Engineering used on AWD –
By-Product: Minimise Integration Risk

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➢ Model contains all interfaces
  ▪ Assign Interface risks (Interface Technology Level & Complexity)
  ▪ Assess Risk Profile
  ▪ Tune the Architecture
  ▪ Minimise Integration Risk

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LESSONS FROM THE SEA 4000 AWD PROGRAM

Lessons From the AWD Program

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- Employ System Architecting early

- Able to model capability using SYSML → Effective CDG Interactions

- Simplified complexity enables effective decision process

  - Employment of CAIV

  - Considerations for System Evolution

  - Considerations of Technology Evolution

  - Integration of Integration Strategies

- Full Employment of all SYSML elements not required (or desired)

- IP / ITAR Restrictions Constrains Completeness of a single model

- Supports Integration Risk Assessment

- MBSE helps highlight compatibility & terminology issues

**Up-Front Effort in Concept Engineered
increases confidence the capability can be developed and delivered**

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Key Take Aways

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- Do not start with Requirements!! Define the Problem

- Undertake Concept Definition in the Customer/User Language

- Hide Complexity → Complexity is an enemy

- Iterate the reference architecture / consider broad business considerations

- Balance near term (Delivery) as well as Sustainment needs

- Apply MBSE concepts in a targeted manner rather than theoretical
  - OV-5b (Activity Model) most beneficial in concept definition phase

Do not skip Concept Engineering Activities!

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Questions

AWD MBSE Model "Factoids"

Data as at Oct 2012

49	Operational Vignettes
119	Use Cases
281	Segment Level Functions
787	Activities
948	Diagrams
42,222	Elements
16,069	Connections
106	Blocks in Logical Model
953	Blocks in Physical Model
432	Interface Messages

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Glossary

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AWD	Air Warfare Destroyer
CAIV	Cost as an Independent Variable
CDG	Capability Development Group
CDR	Critical Design Review
COTS	Commercial Off the Shelf
DoDAF	Department of Defense Architecture Framework, v2.0, 28 May 2009
IP	Intellectual Property
IRL	Interface Readiness Level
ITAR	International Traffic in Arms Regulation
MBSE	Model Based Systems Engineering
MOTS	Military Off the Shelf
MSI	Mission Systems Integrator
OV-1	Operational Concept Graphic (DoDAF v2.0)
OV-5b	Operational Activity Model (DoDAF v2.0)
RAN	Royal Australian Navy
SE	Systems Engineering
SV-4	Systems Functionality Description (DoDAF v2.0)
SV-5a	Operational Activity to Systems Traceability Matrix (DoDAF v2.0)
SV-8	Systems Evolution Description (DoDAF)
SysML	Systems Modeling Language
StdV-2	Standards Forecast (DoDAF v2.0)

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